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# Curious Controversies: A systemic design lens to understand value conflicts in the smart city

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**Anouk Geenen, Julieta Matos-Castaño, Deger Ozkaramanli, and Mascha van der Voort**

Human Centered Design Group,[1] University of Twente

This paper explores sociotechnical controversies in the smart city context and proposes that controversies are valuable concepts for systemic design research and practice due to their multi-dimensional nature. Smart city visions and initiatives tend to be sources of friction and debate: multiple perspectives and expectations come together, leading to value tensions. In our work, we conceptualise controversies as a constellation of value tensions in the public realm. In this work, we stress the importance of embracing controversies and explore how to stimulate ethical deliberation regarding the soft impact of technologies in smart cities. Using an exploratory workshop approach, we empirically examine smart city controversies and propose that such controversies consist of conflicting concerns and value tensions at the micro-, meso- and macro-levels of system analysis. Our findings indicate that value tensions can arise within (inter-level conflict) or across these levels (intra-level conflict). Controversies can contain both types of conflicts. This analysis highlights the complex nature of sociotechnical controversies and how a better understanding of controversies may eventually help grapple with complexity in systemic design research and practice. Moreover, dissecting a controversy in this

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[1] https://www.utwente.nl/en/et/dpm/hcd/

way into its formative elements allows for triggering ethical deliberation on smart city practices, as it reveals pressing value tensions.

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## Introduction

From newspaper headlines to academic conference themes and paper titles, we cannot escape the abundance of sociotechnical challenges, crises and conflicts we are currently facing. Especially the concept of conflict and how to work with it, rather than against it (i.e. by resolving or ignoring it) has recently gained more academic attention within design research (e.g. Ozkaramanli, 2021; Matic & Matic, 2021; Tromp & Hekkert, 2018; Matos-Castaño et al., 2017) and other fields such as Science and Technology Studies (STS) (Marres, 2007) and sustainability studies (Cuppen, 2018). This was also implied by the 2021 RSD conference theme "playing with tensions," which highlighted value tensions and multi-stakeholder conflicts as key challenges at the forefront of systemic design practice and research. Systemic design often deals with tensions and conflicting requirements that they seek to change or intend to address (e.g. Dorst, 2019; van der Bijl-Brouwer & Malcolm, 2020). How can we embrace these tensions and conflicts as valuable societal feedback?

To address this challenge, we introduce the notion of sociotechnical controversies as a promising new concept to grapple with complexity in multi-stakeholder settings in systemic design research and practice. Building on Li (2012), who introduced a micro-meso-macro structure for the social context of engineering, we propose that controversies contain a micro-meso-macro structure of value expressions entangled through tensions within and across these dimensions. We argue that adopting a systemic perspective means understanding and addressing such tensions in relation to each other instead of dealing with them within the confines of a singular system level or reducing them to singular oppositions.

Controversies have been a subject of study since the second half of the 20th century and have mainly attracted academic interest in the STS community (Pinch & Leuenberger, 2006). Controversies are defined as "situations where actors disagree" (Venturini, 2010; p. 261), signalling issues at stake that are sufficiently important not to be ignored. Building on Latour's notion of ding-politik (2005) and Marres' issue-oriented understanding of public involvement in politics (2007), we understand controversies as places where politics "happens"—a diversity of actors and a plurality of perspectives come together, values are negotiated, pathways for action are evaluated, and new social practices emerge.

Since controversies highlight friction between values and, as such, reveal what is at stake, they are promising, holistic concepts when discussing tensions in a multi-stakeholder setting. Although the potential of controversies was recognised decades ago (e.g. Rip, 1987), ways to effectively exploit this potential are scarce. Based on the definition mentioned above of controversies, sociotechnical controversies may have a mediating role in revealing the diversity of values in multi-stakeholder collaboration. As opposing interests can be a source of creative synthesis and a shaper of innovation (Kolloch & Dellerman, 2018), we suggest that consciously embracing controversies and the value tensions they reveal can trigger ethical deliberation and support more responsible practices in sociotechnical contexts. Our contribution, therefore, addresses the following question: How can sociotechnical controversies be conceptualised to support ethical deliberation in smart city projects? To answer this question, we adopt an analytical perspective on controversies by examining four smart city controversies that were identified in two exploratory workshop sessions as part of a transdisciplinary research project on smart cities.

In what follows, we first introduce a theoretical understanding of controversies in the smart city context. We bring insights from smart city discourse and Science and Technology Studies to underline the link between controversies and complexity. We conclude our theoretical analysis with the assumption that controversies can be understood as multi-dimensional value-conflicts, with value expressions on the micro, meso and macro system levels. Next, to further substantiate this theoretical hunch, we explore the multi-dimensional nature of controversies in a workshop using utopian and

dystopian smart city imaginaries with quadruple-helix stakeholders. Through four identified smart city controversies, we empirically argue how values are expressed at the micro, meso, and macro levels and how controversies are built from conflicts between (inter) and within (intra) these levels. Our findings highlight the complex nature of sociotechnical controversies that exist within the smart city discourse and support an understanding of controversies as multi-dimensional value-conflicts. We end with a reflection on how this insight can help to support ethical deliberation in systemic design practices.

## Smart cities

Smart city developments have been met with optimism and opposition in their aim to optimise city life and have led to sociotechnical controversies around, for example, smart surveillance and datafied urban space. Smart city visions hold the promise to improve city life through real-time insight into the datafied and digitised urban environment, which will allow for analyses, prediction, and optimisation of city processes. This clean, computed, and centrally controlled version of a city implies a techno-fix for complex social, economic and environmental issues. The smart city paradigm is heavily debated and criticised for its technological solutionism and reductionist approach to urban life (Kitchin, 2014; Söderström et al., 2014), focus on efficiency and economic profit (Hollands, 2015; Wiig, 2016; Grossi & Pianezzi, 2017), the illusion of political neutrality (Kitchin, 2014; Söderström et al., 2014), potential to deepen social inequalities and marginalisation (Hollands, 2008; Söderström et al., 2014; Grossi & Pianezzi, 2017), and neglect of citizen's experience and perspective of the city (Vanolo, 2016; Cardullo & Kitchin, 2019). Following this critique, recent developments have shown a shift of smart city projects from top-down, corporate-driven, techno-centric activities to a more bottom-up, citizen-inclusive, and people-centric approach, thereby moving away from its initial technological premise and emphasising the smart city as a social endeavour (Trencher, 2019; Joss et al., 2019). Yet, the smart city remains a contested form of public space. Smart city technology has the potential to empower or disempower, include or exclude different perspectives and support or suppress certain voices, leading to friction and controversy (Kitchin, 2014; Valdez et al., 2018).

## Controversies and complexity

sociotechnical controversies are public disputes that arise through the introduction and use of technology in society (Callon et al., 2009). We argue that controversies are important to embrace rather than ignore, as they concern situations where values are at stake: Actors gather because something is important to them. They are examples of wicked problems constituted of ethical issues (Sweeting, 2018). Moreover, These sources of tension form the foundation for conflict and negotiation, where "actors are unremittingly engaged in tying and untying relations, arguing categories and identities, revealing the fabric of collective existence" (Venturini, 2012; p. 796).

The relation between controversies and complexity is further detailed in Venturini's work (2010), from which we recognise five main characteristics that make controversies relevant for systemic design: (1) they involve a diversity of actors, (2) they consist of unpredictable social interdependencies, (3) they are irreducible, (4) debated and (5) signify conflicts. We elaborate on these characteristics by conceptualising them in smart cities:

(1) Diversity of actors: Controversies involve a diversity of actors, including humans and non-humans (i.e. technologies (Venturini, 2010). Working with quadruple-helix stakeholders that represent governmental, corporate, research, and civic interests is becoming a more common practice to bring diverse (human) stakeholders together (Arnkil et al., 2010). Moreover, due to its active role in shaping urban interactions – for example, surveillance cameras in streets modify the behaviour of citizens in public space – technology becomes an additional active actor in smart city scenarios.

(2) Unpredictable social interdependencies: Controversies consist of unpredictable social interdependencies that evolve over time, creating new nodes and connections that could not be foreseen. Controversies are not static but dynamic places of social processes: new action groups emerge, and issues are highlighted differently over time (Cuppen et al., 2020). For example, controversies about smart policing trigger discussions related to the connection between technology and discrimination.

(3) Irreducible: Controversies cannot be reduced to single questions that require an answer. Asking, "how can we make our cities smarter?" will lead to additional questions about what "smart" means, according to whom, whether technology is needed and whether "smarter" is a desirable objective. The challenge and beauty of dealing with controversies lie in agreeing on both what the questions and the viable responses are.

(4) Debated: Controversies generate debates about issues that used to be taken for granted, creating dynamics between matters-of-fact and matters-of-concern (Latour, 2005). For instance, a few decades ago, there was no public debate about privacy issues in the city. Nowadays, with the introduction of sensors in cities to measure human activity, society has become aware of the implications of these technologies for us, making privacy a priority issue in the social sphere.

(5) Conflicts: Controversies are made up of conflicting values (i.e. value tensions). Given the diversity of frames of references involved in controversies, they result in disagreement and are often disputed (Callon et al., 2009). For example, surveillance cameras in the smart city can be viewed as contributing to urban safety but can also be perceived as invading the right to privacy and anonymity in the city.

Complementing earlier work by Ozkaramanli (2021), we introduce a macro-meso-micro architecture (e.g. Li, 2012) to understand controversies as multi-dimensional conflicts. Translating this to the smart city context, this entails value expressions on the micro level (regarding the individual lived experiences of the city), the meso level (regarding the social and relational experiences of the city) and the macro level (regarding the societal and political experiences of the city). We argue that controversies exist of multiple conflicts within and across these levels. Instead of opposing ends of a binary, such as the privacy vs safety debate that is often depicted when discussing surveillance cameras in the smart city, we argue that controversies might better be understood as multidimensional concepts, as an interplay of multiple conflicting concerns and value tensions (where we understand concerns as expressions of values).

If we look at some well-known sociotechnical controversies, such as the debate about abortion, smart camera surveillance, or, very recently, the Corona-app, we argue that what makes these debates so complex and controversial is their multi-dimensionality.

They cannot be reduced to a simple yes/no question, a mere pro/con perspective, or a sole issue of concern. Consider, for instance, the debate on abortion. Madeleijn van den Nieuwenhuizen (2022) explores the various nuances, grey areas, arguments, doubts and conflicting value expressions that build this controversy and provide it with its richness in her recent (Dutch only) work: Leven en laten leven (Live and let live, 2022). The abortion debate highlights that multiple concerns are at play simultaneously. Individual preferences, social critique, and political prolificacy exist next to and often in tension with each other. As such, a controversy represents an intricate web of concerns and value conflicts that cannot be easily navigated or solved. In order to utilise the potential of controversies to act on complex collective problems, it seems key to understanding the elements and the interdependencies present in this complex web of concerns. To further substantiate this theoretical hunch, we explore the multi-dimensional nature of controversies in a workshop setting, using utopian and dystopian smart city imaginaries with quadruple-helix stakeholders (see Figure 1) (Arnkil et al., 2010).
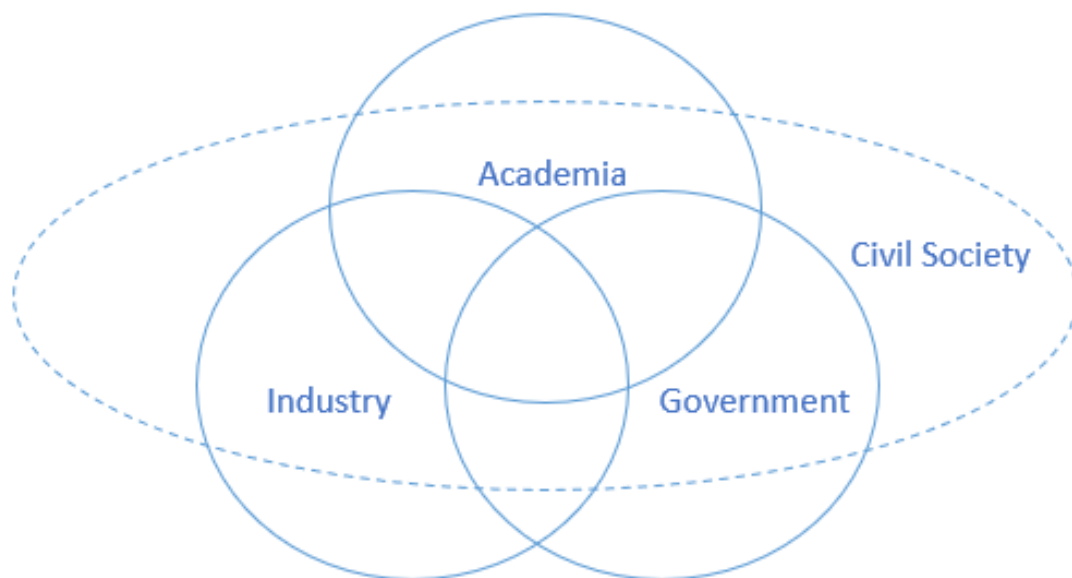


Figure 1. The quadruple helix consists of four strands of stakeholder groups: Government, Industry, Academica and Civil Society.

# Method: an exploratory workshop to explore multi–dimensional controversies

This section describes a workshop approach[2] to surface and explore smart city controversies. We proceed by explaining the process of data-analysis that led to insights on value tensions present in controversies

In order to surface and explore the sociotechnical controversies related to smart cities, we developed a workshop approach in which participants were asked to imagine utopian and dystopian scenarios of the future city (Matos-Castaño et al., 2022). Such imaginaries ground the values and beliefs people have on the city (Bina et al., 2020). The process of framing and reframing when moving from dream to nightmare scenario triggered the formulation of value tensions and conflicting concerns and supported the surfacing of controversies (Figure 2). By making these utopian and dystopian imaginaries explicit and contrasting them, we could make the controversies come to light and analyse the value-tensions present in them. The workshop approach was supported by thoroughly prepared templates to capture participants' input for data analysis. These templates were fully anonymous and not retraceable to participants.

We implemented this workshop approach in two sessions (spring 2019). In total, 61 participants contributed, with 41 participants in the first event and 20 in the second. The participants came from diverse backgrounds and represented different strands of the quadruple helix stakeholders (see Figure 1), such as local and regional government officials, real estate developers, technology developers, researchers and students, with civil society being the least represented stakeholder. All workshops were held in the native language of the participants (Dutch) to ensure that the participants could fully and freely express themselves. During the workshop, participants were divided into smaller groups of 6-9 people to stimulate focused, shared discussions.

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[2] Developed in collaboration with Design Innovation Group as part of the (partly) NWO-funded project "Designing for Controversies in Responsible Smart Cities" (project number CISC.CC.012).
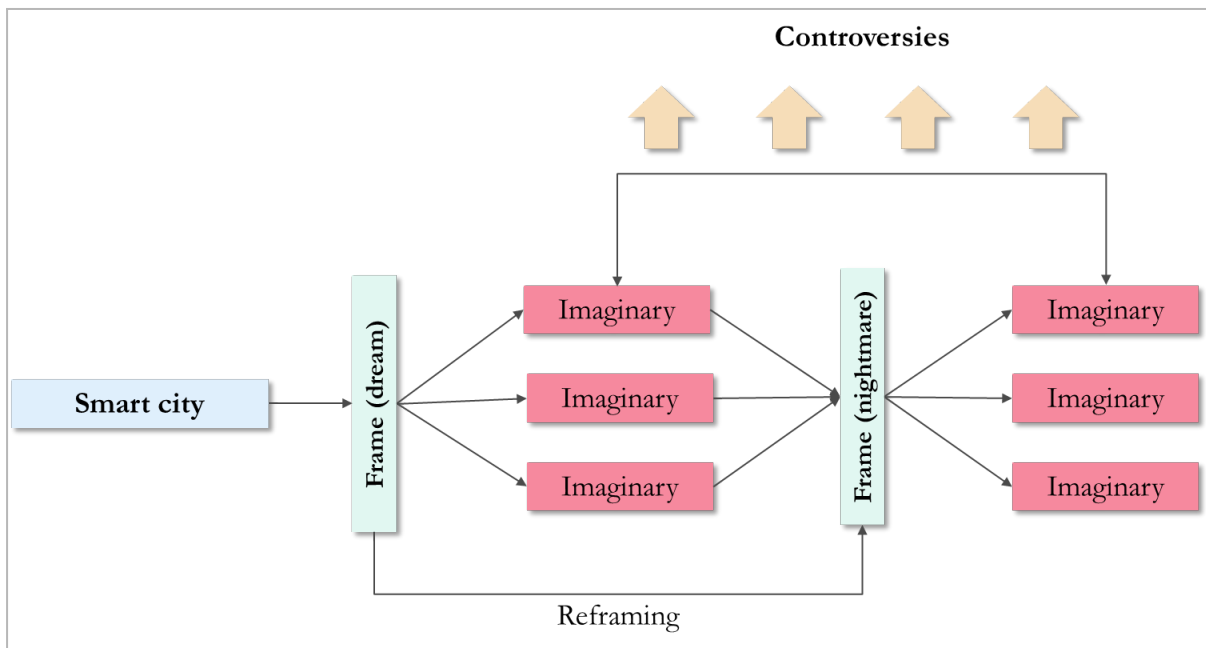
Figure 2. Making controversies come to light through exploring dream and nightmare scenarios for the smart city. This framing and reframing of imaginaries allows key concerns, values and value tensions to surface.

## Workshop approach

The workshop approach consisted of five steps that took place over a 90-minute session. First, participants reviewed a visual of a certain city area that highlighted what type of data is being collected in public space by public and private organisations. This allowed participants to create a shared understanding of technological possibilities in the smart city and probed them for the next step. Next, participants were asked to create their *dream scenario* for a smart city. To prevent them from immediately thinking about potential risks, we provided three preconditions that would facilitate thinking about dream scenarios: (1) all data can be available, (2) people involved in smart city developments have good intentions, and (3) everything that needs to be properly secured is secured. Moreover, to broaden participants' visions about these scenarios, they received additional technology cards that explained possible applications of smart city technology. We provided the participants with short prompts (e.g. "In a smart city, it would be wonderful … ") and templates to facilitate systematic data collection and

analysis. After discussing the identified dream scenarios with each other, participants created a top-3 of their shared dream scenarios through voting. With the help of the facilitator, the group could narrow down the number of scenarios as input for the next step. This step concerned the nightmare scenarios, to be formulated as potential risks and downsides of the top-3 dream scenarios. Finally, participants contrasted dream and nightmare scenarios to surface value tensions and identify controversies. A more detailed version of the protocol can be found in Appendix A.

**Data analysis**

The collected data consisted of (1) notes and templates filled out by the participants during the workshops and (2) notes taken by the facilitators during the workshops. To analyse the data, we used a qualitative, interpretative approach, which aligns with the exploratory nature of this research (Verschuren et al., 2010). We used open, emergent coding to distil main themes (formulated as abstract values such as democracy, sustainability or autonomy). A visual representation of the data analysis process can be found in Figure 5.

We translated and transcribed the dreams and nightmares that participants formulated during the workshop, which all contained less than 100 words as they were collected on prompted sticky notes. We followed the categories and labels provided by the participants during the session. Next, we conducted open coding (Bryman, 2015) to connect the concerns to values. We define concerns as individual expressions of abstract values voiced directly by the participants. To connect concerns to values, we read through the data multiple times and identified tentative categories for chunks of data, which revealed the underlying values of the dream and nightmare scenarios. For example, when participants' imaginaries focused on saving time in the city, we allocated the code "efficiency", or when they focused on the ability to make your own choices, we allocated the code "autonomy". We then grouped concerns as micro, meso or macro level concerns (Li, 2010) according to the scheme in Table 2. Following the work of Boenink & Kudina (2020), we note that values are situated entities that must be understood in context. Therefore, we interpreted values at multiple levels, depending on the associated concern. For example, privacy could be expressed as a matter of personal privacy (i.e. not wanting to be followed and being able to move anonymously

through the city), thus an individual concern, or it could be expressed as public value (i.e. the human right to privacy and the fear for a Big Brother State) and thus a societal concern. This is core to our analysis, as we are not looking for a list of pure values but are aiming to understand the values in context and their associated concerns voiced in the participants' answers.



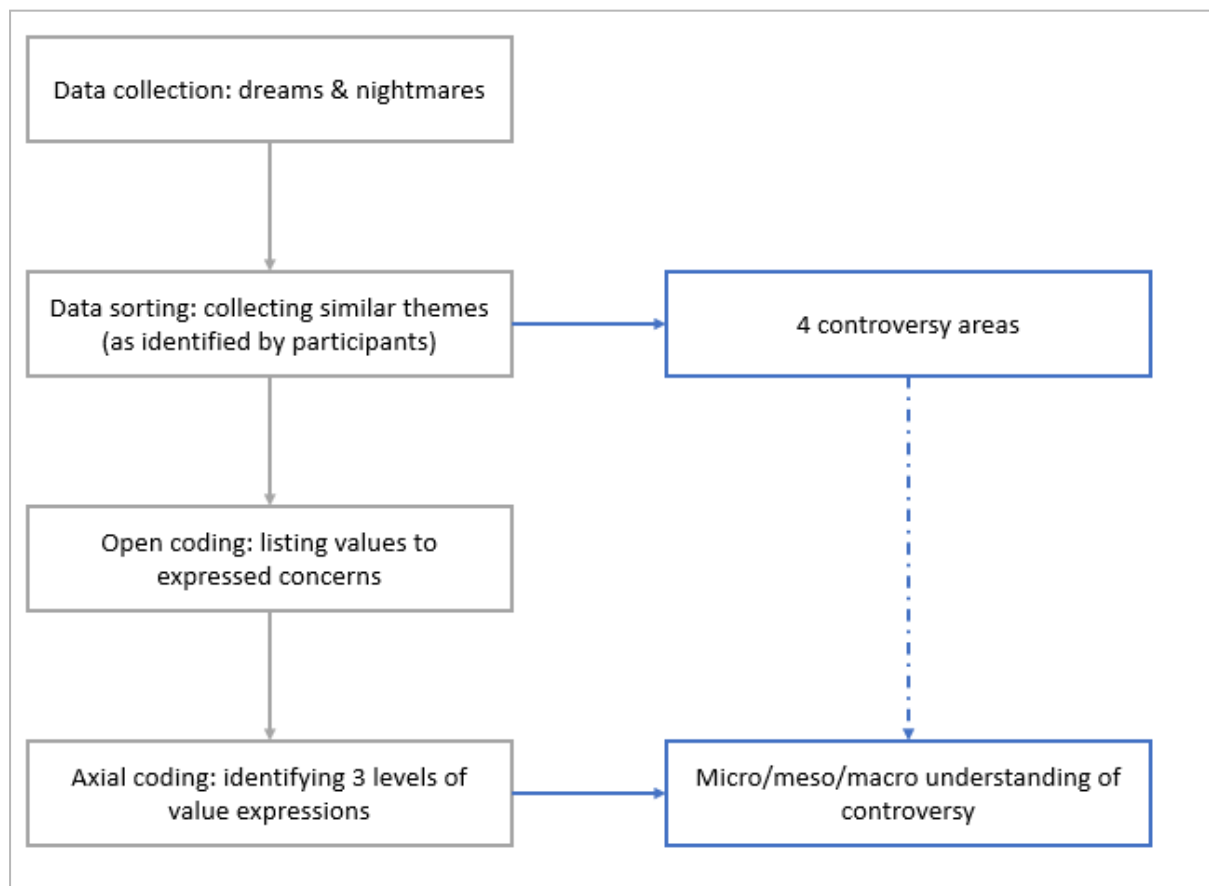Figure 5. Flow-chart representation of the data-analysis process.

Contrasting the utopian and dystopian scenarios provided a breeding ground for surfacing controversies, through which we identified four controversy areas from participants' literal quotes and comments (Appendix B). We recognised two main types of conflicts when identifying the controversies: intra- and inter-level conflicts. Intra-level

conflicts represent the value tensions that exist within a (micro/meso/macro) level, thus, for example, a micro-level concern conflicting with another micro-level concern. Herein, we recognise two different types of conflicting concerns: (1) within the same value theme and (2) between different value themes at the same level. Inter-level conflicts represent tensions that exist between value themes that are expressed on different levels: for example, a micro-level concern conflicts with a meso- or macro-level concern.

Table 2. Coding scheme for micro-meso-macro architecture, containing one example from the dream scenarios and one example from the nightmare scenarios for each level.

| Level | Expression of values (concerns) |
|-------|--------------------------------|
| Micro | the personal perspective and individual experience of the city<br>"I can always find a seat on a sunny terrace"<br>"I have the right to struggle" |
| Meso | the social interaction, relational aspect, and community life of the city<br>"Technology contributes to the happiness of people, facilitating contact between them"<br>"There is less understanding of other groups" |
| Macro | the global, societal and political elements in a city<br>"With better insights of data to accelerate the energy transition"<br>"Tech companies have too much control of technology" |

By comparing these levels of value expressions with the themes that followed from the contrasting dream and nightmare scenarios, we could discern the values and value tensions that contributed to the controversy. This process was conducted by two researchers (first and second authors) independently. Both researchers analysed the full data of the two workshops, and outcomes were discussed to settle any differences or disagreements.

# Findings

We first present the macro-, meso- and micro-levels and their associated concerns and values. Next, we elaborate on the inter- and intra- level conflicts. Figure 6 illustrates how these inter- and intra-level conflicts may shape a controversy.
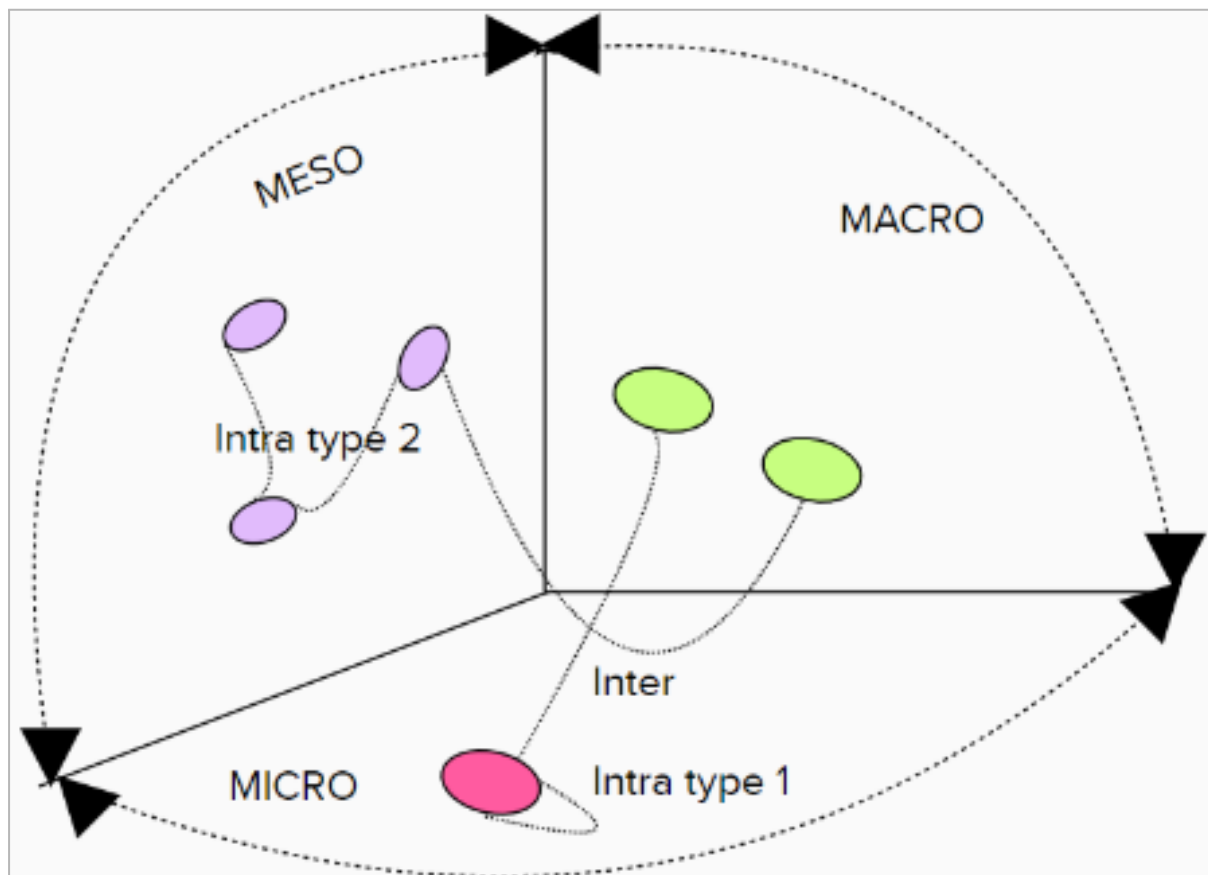


Figure 6. Visualisation of the relations between the levels of concern that conflict with each other in controversy.

**Macro-level concerns**

The macro-level consists of global, societal and political concerns: Participants either dreamed of a city that supports global goals such as sustainability or democracy or feared the impact of technology that might reach beyond the borders of the city (e.g. the loss of autonomy in a world increasingly steered by algorithms). Macro-level

concerns revealed the following thematic values: democracy, autonomy, humanity, sustainability, efficiency, justice and quality of life. For example, regarding sustainability, workshop participants identified the opportunity for "better insights of data to accelerate the energy transition with smart grids." Concerns regarding efficiency were voiced mostly in the realm of interoperability and standardisation of urban technology. Participants indicated the opportunity of the combination of real-time data and ubiquitous IoT to "synchronise systems, like transport and school opening hours." This interoperability on a systems level would lead to higher efficiency in urban traffic and transport. This concern for interoperability was also voiced in relation to sustainability: "with real-time management, we can block roads for polluting cars when sensors notice high levels of air pollution."

Noteworthily, participants expressed more concerns on the macro level than on the meso and micro levels. We saw this both in terms of the number of concerns and the diversity of concerns: the maco level contained a higher variety of concerns compared to the other levels, where two or three key concerns clearly came forward.

**Meso-level concerns**

On the meso level, we recognise concerns that relate to community life and social practices in the city. The thematic values that were highlighted here were social interaction, inclusion, serendipity and human touch. Recurring concerns here relate to the importance of having connections with other citizens; in order to build friendships, but also to be able to communicate authentically with those that have different views and values. Participants shared the fear of growing polarisation, such as 'staying in your own bubble' and only interacting with like-minded people due to algorithmically produced filter bubbles online and in the urban context. Furthermore, at the meso level, we see the desire to implement technology to enhance community-building and shared living, where people look out for and care for one another. For example, dream scenarios suggested using real-time information management to "help and provide services immediately for those in need." Even more straightforward: "technology contributes to the happiness of people, facilitating the contact between them" by, for example, "creating coincidences." The unexpected and serendipitous encounter with new people and places was expressed as a key value for urban life.

**Micro-level concerns**

The micro-level encompasses concerns that relate to individual lives and personal experiences. Two key thematic values were expressed in this level: freedom and personalisation. With regard to personalisation, the main concern here relates to the development of technologies that fit the different competencies and needs of individuals. When it comes to freedom, the micro-level contains concerns about the freedom to make mistakes: participants worry that ubiquitous and data-driven technologies will lead to "losing the right to be imperfect." Participants highlighted that optimisation and personalisation are not always desirable, as "humans have the right to struggle." It is through struggle that you learn and grow: by choosing the wrong route, you enhance your knowledge of the city map; or by ordering unhealthy food, you learn what is good and not for your body. Moreover, freedom also relates to the freedom to choose: being able to choose whether or not to use a certain technology, accommodate algorithmic decisions or deviate from them. Participants shared a desire for "an option to opt-out." Freedom is also voiced in the concern of privacy, which is translated by participants in the need for freedom of identity and freedom of action:"'you can be yourself, have freedom and remain anonymous."

**Intra-level conflicts**

Regarding the first type of intra-level conflict, we highlight an example from the macro-level value of democracy. One respondent wished that "citizens have insight into their living environment because it helps to form an opinion on what is necessary, desirable or undesirable," whereas another respondent noted, "what you don't know, doesn't harm you." Another participant worried about to whom all this knowledge, aimed at democratisation and participation of citizens, might be available by questioning, "will there also be foresight for criminals?" These quotes highlight that also, within levels, values might be viewed differently from different perspectives. We interpret these quotes as being driven by a concern for democracy at the macro-level, and they connect to controversy area 3: The democratic city (Appendix B). Although these concerns relate to the same value, they express different interpretations of this value, showing different stances on how citizens should participate in decision-making

about smart city technologies and the amount of information they need to be able to participate.

Regarding the second type of intra-level conflict, take an example from controversy area 2: The scripted city (Appendix B), where we recognised the desire for a more personalised perspective and optimised experience in cities: "I am never in a traffic jam, and I always find the most efficient route from A to B. I can always find a seat on a sunny terrace." However, simultaneously, we recognised a desire to live a free life that is uninterrupted by algorithms and is open to serendipity: "Nothing can just happen to you" in a highly personalised and optimised city. Albeit both are desirable values, striving for one value might put pressure on the other and, thus, create value tensions at the same, in this case, micro level.

**Inter-level conflicts**

Going back to the desire for a more personalised perspective and optimised experience as expressed in the quotes: "based on your data, the city would be personalised to you," and "In a smart city, I can meet like-minded people and only do things that I am interested in," we see the tension here with the micro-level value of personalisation and the meso-level value of social interaction: "You stay too much in your comfort zone, with too little contact with other people," and "you don't get exposed to new things, only whatever you like. This leads to segregation and polarisation, and less understanding of other social groups. This conflict relates to controversy area 4: Bubbled and isolated citizens (Appendix B). It highlights tensions between various values, all worth pursuing but not always all achievable simultaneously, leading to controversies. Going back to controversy is 3: The democratic city, we find another example in the macro-level value of democracy and its expression through "citizens give their opinion about policy decisions," which exists in tension with the meso-level value of inclusion, where participants indicated worries about the "exclusion of minority groups since their voices are less loud," especially with majority voices being amplified by technology and algorithms.

## Discussion

In this contribution, we have introduced the notion of sociotechnical controversies as a promising new concept to grapple with complexity in multi-stakeholder settings in systemic design. Our findings show that a controversy consists of multiple tensions within and across concerns on the macro-, meso- and micro levels. Analysing and dissecting a controversy into its formative elements is the first step to understanding the complexity inherent to controversies, as we have attempted in this contribution. In the following, we reflect on the insights gained from the workshop results and propose controversies as meaningful entry points for ethical deliberation following our understanding of them as multi-dimensional value tensions. Finally, we suggest that the next steps further the application of controversies in systemic design activities.

### Reflection on results

Not all levels of concern were expressed equally: participants expressed more concerns on the societal level than on the social or individual level. This difference could be related to the workshop approach: we explored generic smart city scenarios. A focus on personas and individual experiences within such a smart city scenario could potentially peel out more concerns on the meso-and micro levels and is worth investigating in further research. Another explanation lies in the fact that macro concerns are also more strongly portrayed and present in the media: for example, concerns on surveillance, sustainability and privacy have made headlines several times, whereas social concerns and citizen's needs tend to get way less attention, to the critique of many (e.g. Vanolo, 2016; Cardullo & Kitchin, 2019). This underlines the importance of teasing out controversies and understanding the multiple concerns and value conflicts that exist simultaneously and at different levels beyond those most prominently portrayed in the media.

Furthermore, the current analysis does not distinguish between concerns or tensions between different stakeholders from the quadruple helix. It would be meaningful to add this layer of analysis in the next iterations, as well as include civil society more strongly in the participants to ensure a fair representation of concerns.

**Implications**

From a systemic perspective, the expression of values and value tensions at multiple levels highlights the complex and rich nature of controversies. Our sociotechnical reality cannot be reduced to a binary opposition (Venturini, 2010), to pro or con, to 1 or 0: the challenges we face and debates that follow are more nuanced and rich than we nowadays often see portrayed in the (social) media and political landscape. Linking micro, meso and macro value expressions and the inter- and intra-level conflicts that follow offer an opportunity to explore this nuance and richness.

We suggest that embracing tension and controversy serves as valuable societal feedback in our path towards more just, responsible and sustainable futures. Given that controversies are carriers of value tensions and reveal which values are pressured and prioritised, we suggest the potential of controversies as meaningful entry points for ethical deliberation, as they provide immediate access to the issues and values at stake (or in Latourian terms, to the matters-of-concern (Latour, 2005)). The need for such ethical deliberation on technology is widely recognised, both in and outside academia. Methods like Value Sensitive Design (Friedman & Hendry, 2019), which offer a fixed set of values as a means of a checklist when designing and implementing new technologies, have been developed as a reply to this need. Albeit a helpful and highly applied approach, it is much criticised for its use of a fixed list of values (e.g. Le Dantec et al., 2009). This reduces the ethical and political conversation to a design requirement that has to be checked off the list and neglects the fact that values are situated, contextual and mediated by technology (Boenink & Kudina, 2020). Working with controversies provides a response to this, as they offer a means for value discovery (Le Dantec et al., 2009), whereby values are recognised lived experiences that need to be understood in context and in relation to each other. Controversies allow access to the situated values that are of public concern, and thereby controversies function as meaningful entry points to elicit ethical inquiry. To turn this inquiry into actionable steps, we suggest mapping the value tensions present in controversies as a means to inform the design process (e.g. Matos-Castaño et al., 2020; Geenen et al., 2022). Following Kolloch & Dellerman (2018), we understand these value tensions as a source of creative synthesis. Examples of this can be found in the recent work of Baibarac-Duignan et al. (2022),

where value tensions between stakeholders in the smart city form the basis for design intervention in the form of a virtual experience that stimulates ethical reflection on the smart city with citizens.

Furthermore, we anticipate that the inter- and intra-level conflicts require different means of approaching them, as these conflicts have different qualities and add different things to the discussion. The micro-level concerns, for example, relate more to personal emotions, whereas the macro-level concerns relate more to politics. Regarding the inter-level concerns on the micro level, dilemma-driven design (Ozkaramanli, 2017) offers a meaningful approach to dealing with these types of conflicts. Addressing inter-level conflicts is a new endeavour, which requires more research in order to understand how to address this particular type of conflict and meaningfully leverage the tensions in it.

**Next steps**

Future research is needed to explore how the analytical framework proposed in this paper can be transformed into a generative one to utilise controversies in creating responsible smart cities. An important balance to maintain whilst exploring controversies in a designerly manner is to keep controversies manageable and actionable without reducing or simplifying their complexity and richness. A systemic design lens can help to keep the nuance and richness that sociotechnical controversies carry.

The lens of controversies outlined in this paper offers a theoretical contribution to the work on the dilemma-driven design (Ozkaramanli, 2017) and dilemma thinking in systemic design (Ozkaramanli, 2021). Dilemmas and controversies are both conflict-driven concepts that may complement each other. However, this complementarity needs further research that bridges two different fields of design, namely human-centred design and systemic design. Dilemma-driven design, as proposed by Ozkaramanli (2017), relies on a phenomenological understanding of dilemmas and strictly focuses on individual dilemmas as fruitful starting points to create innovative products and services. Despite being valuable in human-centred design, solely focusing on the experiences of citizens would not suffice in systemic design. In

this paper, we situate individual dilemmas (micro-level conflicts, also see Ozkaramanli, 2021) as part of a constellation of conflicts that make up controversies. In this way, we connect human-centred design and systemic design and contribute to expanding dilemma-driven design through the lens of controversies. Future research is needed to further explore the possibility of expanding the dilemma-driven design framework to encompass the complexity present in sociotechnical controversies.

## Conclusion

In this work, we have explored the composition of sociotechnical controversies, and we suggest them as meaningful concepts to navigate complexity present in the challenges faced by systemic design researchers and practitioners. Through an exploratory workshop approach, we surfaced and empirically examined sociotechnical controversies in the smart city context. Our findings show that a controversy consists of multiple tensions within and across concerns on the macro-, meso- and micro levels. The multidimensional nature of controversies makes them rich and insightful concepts to grapple with complexity often present in systemic design activities. Moreover, unpacking this multi-dimensionality triggers ethical deliberation as it provides a rich insight into the conflicting concerns and situated value tensions in the sociotechnical context.

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# Appendix A

The workshop approach consisted of five steps that took place in an approximately 90-minute session. A detailed summary of the workshop protocol is summarised in Table A1. More information on this workshop approach can be found in Matos-Castaño et al. (2022).

Table A1. A detailed summary of the five-step workshop protocol to elicit smart city controversies.

| Step | Duration | Goal | Process |
|---|---|---|---|
| 1. Setting the Scene | 15 min | A shared understanding of the smart city | Participants receive a visual of a certain city area; this can be either a residential street or a central city square (example in Figure A1). This visual gives participants insights into current data collection points in the city and makes evident what type of data is collected in public spaces by either public or privacy organisations. Participants are probed with the following questions to create a shared understanding of the smart city: (1) what is the first thing you notice? (2) what is the most surprising element of the visual? and (3) any other additional comments? |
| 2. Formulating dreams | 20 min | Three smart city dreams per participant | Participants create 3 smart city dreams each. For this, they receive an "ideal city" template with the following prompts on post-its:<br><br>"In a smart city, it would be wonderful…"<br>"In a smart city…"<br>"In a smart city, I would use technology and data to…"<br><br>To support free thinking without immediately imagining the risks and constrictions, participants receive the following preconditions: (1) all data can be available, (2) people involved in smart city |

| Step | Duration | Goal | Process |
|---|---|---|---|
| | | | development have good intentions, and (3) everything that needs to be properly secured is secured. |
| | | | To stimulate their thinking process and broaden their vision about smart cities, participants receive additional technology cards that explain possible applications of smart city technology. An example of these cards is given in Figure A2. |
| | | | Lastly, participants explain their dreams to each other. |
| 3. Voting | 5 min | Narrowing down the top three shared dreams | Participants receive three stickers and individually vote on their preferred dream scenarios. This leads to an aggregated top three dream scenarios. |
| 4. Formulating nightmares | 20 min | Three nightmare scenarios per identified shared dream | Participants think about the possible risks and downsides of the top three dream scenarios. To this end, they receive a template to reflect on the undesirable consequences of each dream scenario. |
| 5. Identify controversies | 20 min | Discussion on the most prevalent tensions | Participants discuss and reflect on the identified scenarios and value tensions that surfaced, originating from the use of data and technology in the smart city. |

Figure A1. Example of a visual used in workshop sessions displaying a central city square.
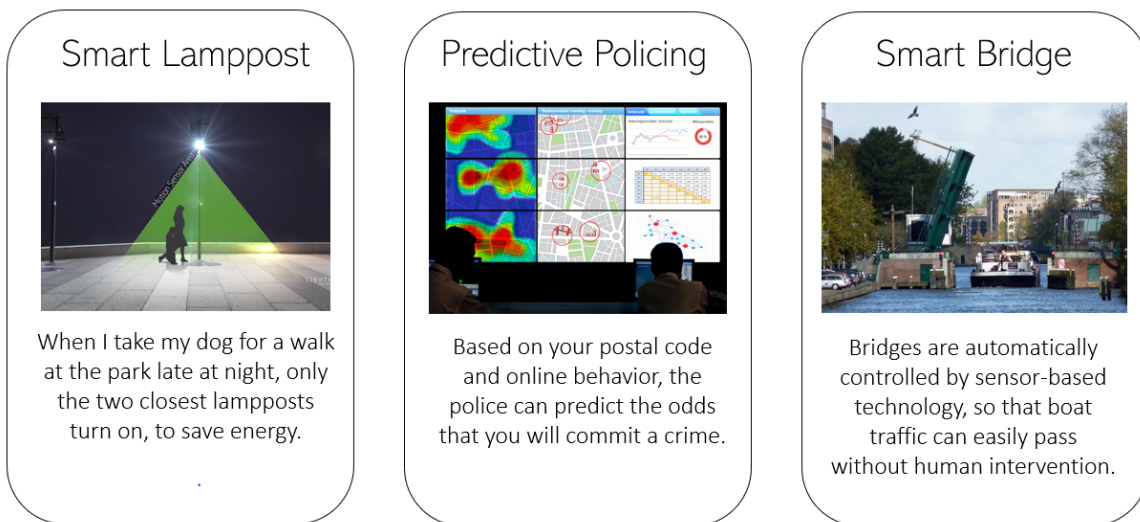


Figure A2. Example of technology cards used to broaden participants' vision of the possible smart city applications. The cards describe both fictional and real smart city technologies.

## Appendix B

Contrasting utopian and dystopian scenarios provided a breeding ground to achieve our goal of letting controversies come to light. During the workshops, participants discovered four main controversy areas:

### Area 1. Passivity and opacity

Technology offers opportunities to improve citizens' urban experience by providing targeted services and activities. No more waiting on the bus or standing in line for a restaurant table: technology will accommodate for your comfort and manage your route according to your preferences. However, outsourcing the provision of joyful and pleasant activities to technology takes the decision power and autonomy away from citizens. Whoever is controlling technology, whether it is corporates or the government, has the power to nudge citizens in any direction. As a result, people become passive spectators of what happens behind the smart city scenes.

### Area 2. The scripted city

Massive data collection and the use of predictive algorithms to improve efficiency turn the city into a predictable play. Technology becomes the writer that scripts the activities of what people should be doing in the city. As a result, people's behaviour and whereabouts become predictable. This reduces serendipity, or the chances of something interesting or pleasant happening by chance. The prediction fever to increase efficiency neglects the importance of unexpected city encounters, which is, in the end, one of the main reasons for people living in cities in the first place.

### Area 3. The democratic city

In a democratic smart city, citizens can take part in policy-making processes, voicing their concerns and wishes. Policy decisions are made transparent, and smart city data is accessible to everyone to guarantee equal insight and knowledge. Ensuring that everybody has digital literacy can contribute to a more flexible and hands-on democracy. However, is there a way to opt out for those who don't want to participate? Will the neighbour with a dissonant voice still fit in? What about marginalised voices?

There is a danger of peer pressure as full transparency will allow anybody to have insight into what others think.

**Area 4. Bubbled and isolated citizens**

Technology filters citizens' experiences and interactions and allows them to meet like-minded people. This relieves anxiety and helps citizens to live within their comfort zone. However, using technology to get targeted experiences could lead to a society where one only encounters what they already enjoy, without getting exposed to new things or people. People remain in their bubbles and disconnect from other people and experiences, leading to polarisation and isolation. There is a risk for a reduced city that does not represent the richness of multiple interacting perspectives, cultures and activities.